CHAPTER 6

R645-301-600 GEOLOGY

Hiawatha Coal Company
Hiawatha, Utah

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R645-301-600 Geology

R645-301-610 Introduction

This chapter discusses the regional and structural geology of the permit area and adjacent areas and it's effects on surface and ground water as well as other related parameters, which may influence reclamation. Maps and cross-sections associated with this chapter have been prepared by or under the direction of a qualified, registered, professional engineer whose stamp and signature can be found on the individual documents in question.

Specific geologic investigations, practices and techniques used to derive the information in this Chapter are based on ~~U.S. Fuel~~ Hiawatha Coal Company records and field investigations along with information derived from sources listed in the References at the end of this Chapter.

R645-301-611 General Requirements

Description of the geology within and adjacent to the permit area are given under R645-301-620 through 627.

R645-301-612 Cross Sections Maps And Plans

All cross-sections maps and plans as required by R645-301-622 have been prepared and certified as described under R645-301-512.100.

The General Map (Exhibit 6-1) is derived mainly from U.S.G.S. Bulletin 819 (Spieker's study of the Wasatch Plateau Coal Field). The map has been extended to the east based on U.S. Fuel Company field investigations. Also, geologic structures encountered during mining have been portrayed based on U.S. Fuel's records.

Cross-sections showing coal seam relationship and lithologic characteristics of the strata surrounding the seams are based on U.S. Fuel Company's diamond drill core samples as interpreted in connection with coal reserve and mining feisability studies conducted by John T. Boyd Company (see references at end of this Chapter).

R645-301-620 Environmental Description

Regional and Structural Geology

~~United States Fuel~~ Hiawatha Coal Company's property is located along the eastern margin of the Wasatch Plateau physiographic subdivision. The Wasatch Plateau lies between the broad uplift of the Colorado Plateau to the east and the highly faulted Basin and Range physigraphic province to the west. The structure of the Wasatch

Plateau is transitional between theses two structural provinces and contains elements of each.

The topography of the area is mountainous and is characterized by the steep, eastern face of the plateau which has been incised by deep, narrow, V-shaped canyons. The escarpment is bounded on the east by a gently sloping pediment surface of low relief and on the east by rolling uplands. Relief along the escarpment is about 2,500 feet. Surface elevations within the permit area range from 7,000 feet near the town of Hiawatha to 10,000 feet on Gentry Mountain near the north western corner of the permit area.

The major drainage of the property include the four forks of Miller Creek and two forks of Cedar Creek on the east and Gentry Hollow creek on the west. Groundwater and stream flow is primarily influenced by direct infiltration of precipitation in the upper elevations of the plateau. Although the surficial material may be relatively less permeable than the underlying saturated beds, considerable amounts of water infiltrates to the saturated beds because of the large areas through which the infiltration occurs.

The geologic formations of the mine plan area are Cretaceous, Tertiary and younger in age and, depending on resistance to erosion, form alternating tiers of cliffs and steep slopes where they are exposed. The sedimentary strata outcropping on Hiawatha ~~U.S. Fuel~~ property belong to five separate and distinct formation, (see Figure 1) comprised mainly of sandstones, siltstones, and shales of both marine and nonmarine origin. Some miner limestone beds occur, mainly near the top of the plateau. Most stream drainages and flatter slopes are covered with quaternary alluvium, alluvium and glacial debris. The stratigraphic characteristics of each formation is described below in ascending order:

Masuk Shale Member of Mancos Shale: The uppermost member of the Mancos shale, the Masuk, represents the last marine invasion into the area. It ranges from 300 to 1,300 feet thick an forms steep blue colored slopes where it is exposed near the town of Hiawatha. In the subsurface to the west it changes faces and joins with the Emery and Star Points sandstones. The Masuk is a soft unit in its exposures but usually forms part of the cliffs near the base of the Wasatch Plateau.

Star Point Sandstone: The lowest of four formations compromise the Mesaverde group of the Wasatch Plateau, the Star Point consists of several thick, cliffy sandstone units separated by shale or partings of thin-bedded sandstone. The unit ranges from 90 to 1,000 feet thick with thicker sections to the west. In the southernmost part of the coal field it contains sandy shale; in the central and north parts it appears as a broad light colored band on the cliffs.

Blackhawk Formation: The Blackhawk in the Mesaverde group of the Wasatch Plateau contains in the lower half of the formation all the coal seams expected to be affected by mining operations in this area. The 700 to 1,000 foot unit, less resistant than the units that contain it, consists of alternating slope and cliff forming units. The cliff forming sandstones are generally yellow-gray to white-gray on fresh surfaces and weather to shades of tan, yellow or brown. In places they are reddened by the natural burning of nearby coal seams. Sands are fine to medium grained and cemented by either calcite or silica. In a few places they are argillaceous. Slopes are comprised of carious types of sale and coal. The shales, continental in origin, consist of three kinds: clay, shale; soft, granular, gray to green in color; carbonaceous shale; the most common in carious shades of brown and black; and smoke gray shale; usually associated with the coal. The coal beds being affected in this mining area lie in the lower 250 to 350 feet of the formation.

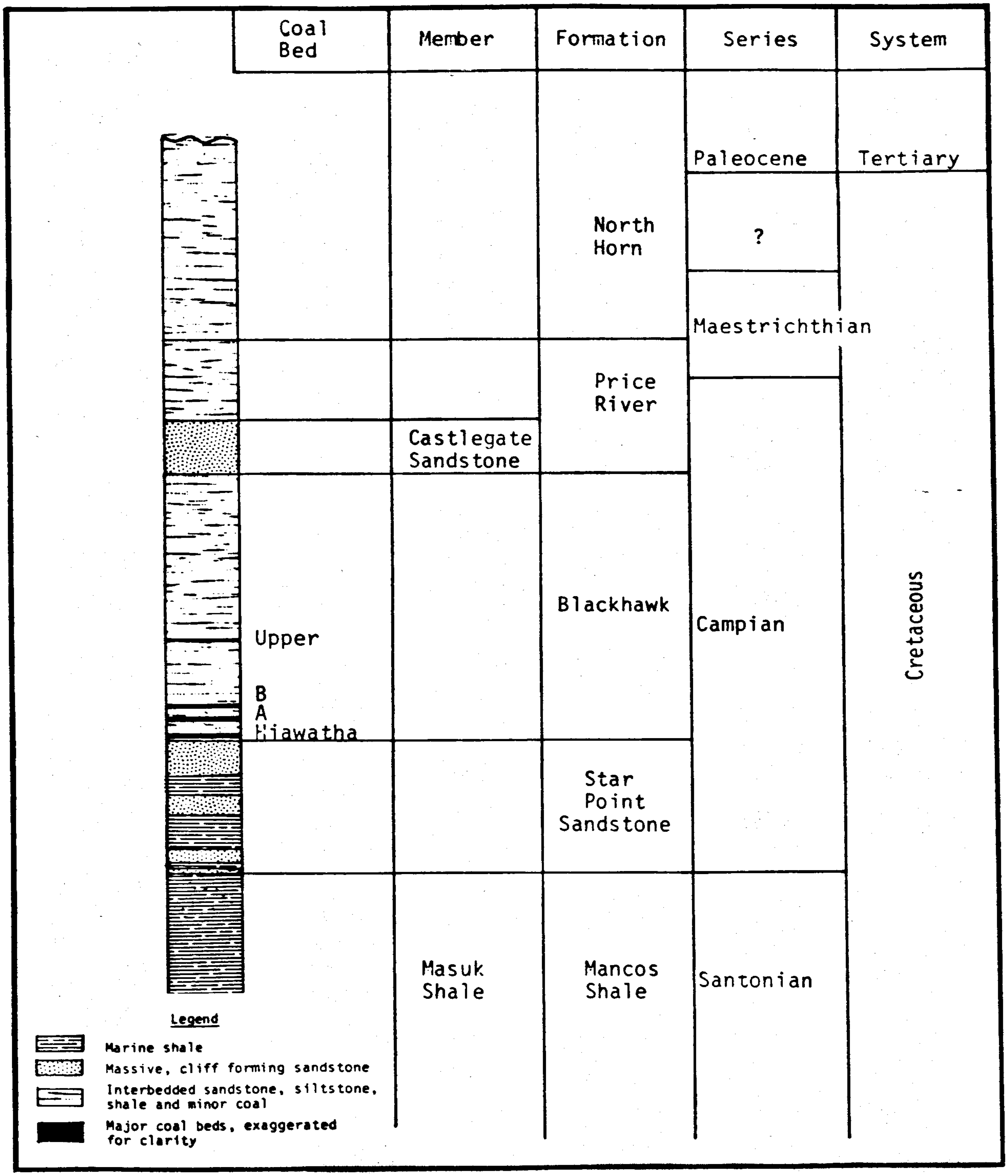

Figure 1 Generalized Stratigraphic Columns, Hiawatha-Mohrland Areas.

Castle Gate Sandstone: The Castle Gate Sandstone, generally carried as a member of the Price River formation, immediately overlies the Blackhawk formation. The Castle Gate varies between 150 to 500 feet thick. Massive, medium to coarse grained sandstone beds in places contain conglomerate with a matrix of grit. This cliffy unit is occasionally broken by sandy, hard, gray shale and even lenses of coal.

Price River Formation: This formation is comprised mainly of sandstone of which the Castle Gate member, which lies at the base, is an easily traceable cliff former. Thickness of this formation is from 700 to 1,200 feet.

North Horn Formation: This is the uppermost formation in the Hiawatha area. It consists mainly of shales with lenses of sandstone and fresh water limestone. The relatively hard limestone lenses cause many of the flat, unbroken surfaces on top of Gentry Mountain. The lower contact of this formation is not well defined as it grades into the Price River formation. Its thickness is from 500 to 2,500 feet. Boreholes collared in this formation for coal exploration have encountered a water-bearing zone at about 300 feet down which has caused selling and sloughing of the holes.

The coal seams of interest occur in the Cretaceous Blackhawk formation. Above and below the Blackhawk are two cliff-forming sandstones, the overlying Castle Gate and underlying Star Point. Each are valuable for correlating the generally lenticular coal beds and helpful in field correlations. Structurally, the beds are relatively plat with a slight dip to the southwest at about 1 to 2 degrees. However, structural rolls locally flatten or steepen the dip. The strike of the coal-bearing strata ranges from N90°E in the northernmost portion of the property to N50°W in the south and southwest. Cover over the uppermost minable seam is moderate, ranging between o and 1,500 feet. The strata are generally undisturbed in the vicinity of Hiawatha, but become more disturbed in the west. Here the Pleasant Valley fault zone, of which the Bear Canyon fault is the most easterly expression, is present and trends north-south through the head of Bear Canyon as shown on Exhibit 6-1. The Bear Canyon Fault, which has a displacement of up to 250 feet and dips 85 degrees to the west, marks the western limit of past UDF mining. Several minor faults ~~have been~~ were encountered underground in the northwest part of the King 4 mine. These faults also strike north south and have displacements ranging from a few inches to 5 feet.

There is no major folding in the area although numerous local rolls have been encountered while mining. Spieker's geologic map of the Wasatch Plateau shows a gentle synclinal basin between Long Point and Wild Horse Ridge near the southern end of Gentry Mountain. Boreholes for coal exploration in that area substantiate his structural contours.

Some igneous intrusions, mostly associated with tension fractures, exist within the mine plan area. Dikes ranging from a few inches to 4 feet thick have been encountered in the Hiawatha No. 2, King No. 3 and King No. 4 mines. The dikes, consisting of a basic lamporphyre material, have caused natural coking where they contact coal beds.

There are no gas or oil wells within the permit area. An exploration hole drilled by Humble Oil in the SW1/4NE1/4, Sec. 13, T.15s., R.7E. near the northern boundary of the permit area reached a total depth of 15,882 feet. This hole is shown on Exhibit 6-3. An exploration hole was drilled by Richfield Oil in NE`/4NE1/4, Sec. 11, T.15s., R.7E. No information on its total depth is available.

Numerous bore holes have been drilled from the surface as well as from within the mines for coal exploration in the permit and adjacent areas. A summary of these holes is given in Table 6-2. Hole locations are depicted on Exhibits 6-1 and 6-3. Note that the holes drilled from within the mines are generally less than 400 feet in depth which is the maximum capacity of the small underground diamond drilling unit.

A surface drilling project was conducted in 1976 and 77 to evaluate coal reserves south of the permit area. These holes were rotary drilled down to the Blackhawk formation then core drilled through the Blackhawk to the top of the Star Point Sandstone formation. Little if any geologic or hydrologic information is available for the rotary drilled portions of the holes. The core samples were retained and their lithologic information over a greater vertical extent than the hole drilled from within the mines they were utilized to a large extent to construct the cross sections in this chapter and in chapter 7.

Some of the drill hole information was lost before Hiawatha Coal Company purchased the Hiawatha Mines. Any cross-sections created by Hiawatha Coal Company are based on U. S. Fuel Company's drill hole information that could be found.

Geology of Coal and Adjacent Units

Four beds or zones of measures coal have been identified in the mine plan area oif which three are thick enough to be economically minable at this time. At the ~~USF~~ Hiawatha mines, these beds have been referred to as the Hiawatha, the A (Blind Canyon), the B (Bear Canyon) ad the Upper (Tank) seams. These seams all occur in the Blackhawk formation. Figure 1 gives a general stratigraphic section showing the relative location of these seams. This information is discussed in connection with the coal seam descriptions below and illustrated in Figures 2 through 5. Figure 6 provides a general north-south lithologic cross-section through the permit area, Exhibit 7-23 shows another north-south cross-section extending from the northern end of Hiawatha Coal Companies permit boundary down through Birch Spring and Big Bear Spring. Exhibit 6-2 gives cross-sections showing coal seam relationships at several locations within the permit area. A drill hole summary is presented in Table 2. Drill hole location can be found on Exhibits 6-1 and 6-3. Seam contours, isopachs, overburdens, and interburdens are given in Exhibits 6-4 thru 6-12.

The coal is ranked as bituminous in the high volatile B and C groups, with low to medium ash content and very low to medium sulfur content. Table 1 summarizes the analysis for these beds.

It is located 5 to 20 feet above the Star Point Sandstone and is characteristically a bright, blocky coal containing visible resin blebs. The immediate roof is comprised of a laminated fine to medium grained white sandstone that ranges in thickness from 6 to 110 feet within the area of interest. The floor is generally hard carbonaceous shale with interbedded siltstone partings underlain by white, medium grained sandstone. Figure 2 shows a typical lithologic description of the Hiawatha seam interval.

Table 1
Summary of Coal Qualities

Seam	**Hiawatha**		**A**		**B**		**Upper**	
	As-Rec'd	Dry Basis	As-Rec'd	Dry Basis	As-Rec'd	Dry Basis	As-Rec'd	Dry Basis
Moisture (%)	4.72	-	4.72	-	5.01	-	4.57	-
Ash (%)	7.69	8.08	5.46	5.71	6.91	7.26	8.27	8.64
Volatile Matter (%)	41.64	43.69	41.58	43.80	41.85	44.06	42.41	44.46
Fixed Carbon (%)	45.95	48.23	48.14	50.49	44.43	48.68	44.75	46.90
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Btu	12,656	13,294	12,994	13,629	12,661	13,331	12,718	13,331
Pyritic Sulfur (%)	0.16	0.18	0.13	0.15	0.06	0.07	0.09	0.10
Sulfate Sulfur (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Organic Sulfur (%)	0.61	0.64	0.65	0.67	0.50	0.52	0.56	0.59
Total (%)	0.77	0.82	0.78	0.82	0.56	0.59	0.65	0.69

Hiawatha Seam: This seam is the lowest and most consistent seam in the Blackhawk formation. It's thickness is from 3 to 4 feet in the northern part of the property where it is separated by rock splits to over 24 feet of solid clean coal where it merges with the A seam near the southern boundary of the property.

A Seam: The A seam splits off from the Hiawatha seam between Cedar Creek Canyon and South Fork, where it gradually increases its elevation above the Hiawatha from 0 to 60 ft. to the north. The seam thickness ranges from 0 to 12 ft. The A seam is composed of moderately bright to bright coal with come resin inclusion and occasional bony coal and carbonaceous shale partings. The strata that immediately overlies the A seam consists of interstratitied carbonaceous shale, gray siltstone, and thin, white, fine to medium grained sandstone. The seam floor ranges from carbonaceous shale underlain by interbredded gray shale and siltstone to soft claystone or mudstone (underclay). The A seam in the area of interest may be correlative to the Blind seam of the surrounding area. Figure 3 shows a loghologic description of the A seam. This seam has been mined in parts of the King No. 1 and King No. 4 mine.

B Seam: The B seam occurred 0 to 70 feet above the A seam. The seam may be correlative to the Bear Canyon and Wattis seams of adjacent localities. In an area west of South Fork, A and B seams come together forming a bed from 12 to 18 ft. thick. The B seams underlying the northern mining area is split into two benches with 3 to 5 ft. shale parting between them. The upper minable bench consists of moderately bright to very bright coal and commonly contains resin inclusion and thin carbonaceous shale and sandstone bands. The upper B bench is from 4 to 12 ft. thick. The lower B bench consists of moderately bright to bright coal, free of partings. The B seam roof is a variable sequence of interbedded carbonaceous silty shale and gray siltstone. Some thin, light gray, fine-grained sandstone underlies the carbonaceous shale. A lithologic description of the B seam is shown on Figure 4.

Upper Seam: The Upper seam has never been mined by USF and is located approximately 300 ft. above the B seam in the northern part of the property and 330 ft. above the Hiawatha seam in the Mohrland area. The maximum thickness is less than 6 ft. The central portion of the ~~USF~~ Hiawatha property is essentially devoid of information on the Upper Seam with the exception of three closely spaced drill holes that show the seam to be between 1.2 and 2.2 ft. thick in that area. The immediate roof above this seam is gray carbonaceous shale overlain by white, fine to medium grained sandstone. The floor is gray carbonaceous shale. Figure 5 shows a lithologic description of the Upper seam.

Table 2

U.S. Fuel Company Drill Holes Summary

Drill Hole No.	Direction of Drilling	Total Depth of Hole	Where Collared	Collar Elev.	Surface Elev.	Upper Seam Height	Upper Seam Elev.	Interval Between Upper and B Seams	B Seam Height	B Seam Elev.	Interval Between B and A Seam	A Seam Height	A Seam Elev.	Interval Between A and Hiawatha Seams	Hiawatha Seam Height	Hiawatha Seam Elev.
1	Up	148.4	Hiawatha	8,096	8,670	-	-	-	5.3	8,221	74.5	2.5	8,144	35.7	12.3	
2	Up	156.2	Hiawatha	8,150	8,750	-	-	-	5.9	8,285	55.5	0.5	8,229	79.0	13.0	8,084
3	Up	155.0	Hiawatha	8,174	8,750	-	-	-	5.5	8,295	60.5	0.5	8,234	53.0	19.0	8,137
4	Up	164.0	Hiawatha	8,108	8,590	-	-	-	4.5	8,251	110.5	0.5	8,140	20.0	12.0	8,162
5	Up	405.8	Hiawatha	7,716	8,750	5.3	8,071	47.0	3.8	8,023	173.0	0.6	7846	129.8	19.8	8,108
6	Up	170.0	Hiawatha	7,749	8,670	-	-	-	1.2	7,884	-	-	-	-	22.0	7,696
7	Up	473.8	Hiawatha	7,816	8,990	4.2	8,186	-	-	-	-	-	-	-	23.8	7,727
8	Up	468.0	Hiawatha	7,893	9,070	3.2	8,274	-	-	-	-	2.5	7,962	59.6	9.4	7,792
9	Up	257.0	Hiawatha	7,939	8,510	-	-	-	2.0	8,072	114.5	4.0	7,972	22.5	10.5	7,884
10	Up	468.0	Hiawatha	8,044	9,150	2.2	8,474	307.8	6.2	8,160	67.0	10.0	8,083	29.9	9.1	7,939
11	Up	468.5	Hiawatha	8,100	8,750	2.0	8,532	310.2	5.0	8,217	74.2	5.8	8,137	36.8	11.2	8,044
12	Up	469.4	Hiawatha	8,200	8,670	-	-	-	3.7	8,313	-	-	-	-	7.3	8,089
13	Down	952.0	Surface	8,988	8,985	1.5	8,609	413.2	5.8	8,190	41.8	8.2	8,148	26.0	8.0	8,200
14	Up	59.0	Hiawatha	8,054	9,710	-	-	-	-	-	-	5.2	8,105	-	-	8,106
18	+60°	70.0	Hiawatha	8,022	8,590	-	-	-	-	-	-	5.0	8,076	46.0	8.0	-
20	+60°	62.0	Hiawatha	8,022	8,590	-	-	-	-	-	-	6.0	8,073	42.0	9.0	8,022
21	+60°	42.0	Hiawatha	7,992	9,470	-	-	-	-	-	-	5.0	8,027	26.0	5.0	7,983
23	+60°	53.0	Hiawatha	7,945	9,590	-	-	-	-	-	-	-	-	-	8.0	7,945
24	+75°	52.8	Hiawatha	8,035	8,510	-	-	-	-	-	-	7.8	8,080	36.5	8.5	8,035
25	Up	54.0	Hiawatha	8,078	9,070	-	-	-	-	-	-	7.2	8,114	36.3	9.0	8,069
31	Up	150.0	Hiawatha	8,053	9,390	-	-	-	4.8	8,192	77.7	4.8	8,109	56.0	8.0	8,046
37	Up	100.0	Hiawatha	7,917	9,390	-	-	-	-	-	-	1.2	7,955	34.5	13.8	7,902
39	Up	88.5	Hiawatha	7,960	9,710	-	-	-	7.0	8,014	33.0	9.0	7,972	9.0	12.0	7,950
40	Up	91.0	Hiawatha	7,991	9,650	-	-	-	8.0	8,064	39.0	7.0	8,018	25.0	8.3	7,983
41	Up	77.3	Hiawatha	7,991	9,650	-	-	-	9.0	8,057	21.7	7.3	8,028	36.7	10.0	7,981
42	+62°	87.9	Hiawatha	7,950	9,630	-	-	-	8.8	7,976	11.0	9.2	7,956	4.4	12.0	7,940

Table 2

U.S. Fuel Company Drill Holes Summary

Drill Hole No.	Direction of Drilling	Total Depth of Hole	Where Collared	Collar Elev.	Surface Elev.	Upper Seam Height	Upper Seam Elev.	Interval Between Upper and B Seams	B Seam16.7 Height	B Seam16.7 Elev.	Interval Between B and A Seam	A Seam Height	A Seam Elev.	Interval Between A and Hiawatha Seams	Hiawatha Seam Height	Hiawatha Seam Elev.
52-1	Up	101.0	Hiawatha	7,914	9,670	-	-	-	6.0	7,968	39.2	6.8	7,922	4.5	3.0	7,914
52-6	Up	63.4	Hia./A	7,956	9,470	-	-	-	16.3	7,993	35.3	1.7	7,956	0.0	-	7,956
52-7	Up	65.9	Hia./A	7,953	9,470	-	-	-	16.7	7,990	35.8	1.3	7,953	0.0	-	7,953
52-8	Up	80.0	Hiawatha	7,937	9,350	-	-	-	-	-	-	-	-	-	1.3	7,937
54-1	Up	50.0	Hia./A	7,960	9,670	-	-	-	6.7	7,973	1.0	21.8	7,950	0.0	-	7,950
54-2	Up	101.5	Hia./A	7,933	9,620	-	-	-	7.8	7,948	1.5	14.0	7,933	0.0	-	7,933
54-3	Up	90.0	Hia./A	7,958	9,670	-	-	-	9.6	7,987	17.8	11.0	7,958	0.0	-	7,958
54-4	Up	57.2	Hia./A	7,951	9,670	-	-	-	10.0	7,978	12.3	14.9	7,951	0.0	-	7,951
63-1	Down	60.9	A	8,101	9,550	-	-	-	-	-	-	-	-	50.7	9.0	8,041
63-2	Up	64.4	A	8,101	9,550	-	-	-	5.5	8,155	50.7	-	-	-	-	-
66-1	Up	-	B	8,138	9,750	-	-	-	12.1	8,130	-	-	-	-	-	-
67-1	Down	-	B	8,130	9,750	-	-	-	-	-	-	6.0	8,115	59.0	4.0	8,052
67-2	Down	-	A	8,122	9,710	-	-	-	-	-	-	9.9	8,122	57.0	5.1	8,060
67-3	Up	-	A	8,132	9,710	-	-	-	7.3	8,150	-	-	-	-	-	-
67-4	Up	-	A	8,132	9,710	-	-	-	-	-	-	7.5	8,132	-	-	-
67-5	Up	-	A	8,132	9,710	-	-	-	6.2	8,150	18.0	-	-	-	-	-
68-1	Down	-	B	-	9,150	-	-	-	6.9	-	59.0	5.5	-	54.5	10.0	-
68-3	Up	-	Hiawatha	-	8,550	-	-	-	-	-	-	3.8	-	-	-	-
68-4	Up	55.3	Hiawatha	8,057	9,150	-	-	-	-	-	-	8.3	8,104	47.0	10.2	8,047
70-1	Down	103.0	B	8,165	9,750	-	-	-	10.0	8,165	1.7	5.3	8,158	-	-	-
70-2	Down	43.0	B	8,200	9,390	-	-	-	5.1	8,200	-	-	-	-	-	-
70-5	Down	306.0	Surface	8,535	8,535	-	-	-	7.0	8,229	75.5	7.5	8,146	23.0	5.0	8,118
70-6	Down	187.0	Surface	8,419	8,419	-	-	-	5.0	8,239	-	-	-	-	-	-
71-1	Up	46.5	B	8,238	8,950	-	-	-	11.0	8,227	-	-	-	-	-	-
71-2	Down	51.0	B	8,227	8,950	-	-	-	11.0	8,227	39.0	5.0	8,183	-	-	-
72-1	Up	103.0	B	8,210	9,830	-	-	-	8.0	8,202	-	-	-	-	-	-
72-3	Up	129.0	B	8,278	9,390	-	-	-	9.0	8,269	-	-	-	-	-	-

Table 2

U.S. Fuel Company Drill Holes Summary

Drill Hole No.	Direction of Drilling	Total Depth of Hole	Where Collared	Collar Elev.	Surface Elev.	Upper Seam Height	Upper Seam Elev.	Interval Between Upper and B Seams	B Seam16.7 Height	B Seam16.7 Elev.	Interval Between B and A Seam	A Seam Height	A Seam Elev.	Interval Between A and Hiawatha Seams	Hiawatha Seam Height	Hiawatha Seam Elev.
72-4	Down	99.0	B	8,269	9,390	-	-	-	-	-	-	8.0	8,231	45.0	2.0	8,184
72-5	Down	58.5	B	8,296	9,030	-	-	-	6.0	8,269	49.0	7.0	8,240	-	-	-
72-6	Down	57.0	B	8,229	9,590	-	-	-	6.0	8,229	35.3	4.7	8,189	-	-	-
72-7	Down	60.0	B	8,203	9,670	-	-	-	10.3	8,203	32.2	3.8	8,176	17.0	3.0	8,156
72-8	Up	93.0	B	8,212	9,670	-	-	-	10.3	8,203	-	-	-	-	-	-
73-1	Down	99.0	B	8,291	9,610	-	-	-	7.6	8,291	56.0	4.0	8,231	-	-	-
73-2	Down	58.0	B	8,246	9,590	-	-	-	7.7	8,246	8.3	4.7	8,233	21.7	4.3	8,207
73-3	Down	53.0	B	8,275	9,430	-	-	-	8.0	8,275	39.5	8.5	8,227	-	-	-
75-1	Up	132.0	Hiawatha	8,090	8,670	-	-	-	5.5	8,154	76.3	6.7	8,071	-	-	-
75-2	Down	63.5	B	8,300	8,990	-	-	-	-	-	-	7.0	8,243	-	-	-
76-1	Down	73.0	B	8,249	9,890	-	-	-	7.6	8,249	10.5	4.5	8,234	-	-	-
76-2	Down	114.0	B	8,355	9,620	-	-	-	8.0	8,355	26.7	4.3	8,324	73.1	1.9	8,249
76-3	Down	110.0	B	8,301	9,870	-	-	-	7.6	8,301	22.8	4.2	8,274	74.4	4.6	8,196
77-1	Down	118.0	B	8,192	9,350	-	-	-	-	-	-	3.3	8,166	86.0	3.0	8,077
77-2	Down	130.0	B	8,209	9,110	-	-	-	-	-	-	5.1	8,153	64.3	4.7	8,084
77-3	Down	145.0	B	8,344	9,150	-	-	-	-	-	-	2.8	8,289	73.3	3.7	8,212
77-4	Down	145.0	B	8,433	9,900	-	-	-	8.0	8,433	27.5	2.5	8,403	91.5	3.5	8,308
85-2	Down	85.0	B	8,408	9,270	-	-	-	-	-	64.0	4.0	8,340	-	-	-
85-3	Down	160.0	B	8,312	8,750	-	-	-	-	-	100.0	9.0	8,212	43.0	3.0	8,171
87-1	Down	68.5	B	8,325	9,110	-	-	-	-	-	46.0	5.3	8,274	-	-	-
87-6	Down	105.0	B	8,305	8,510	-	-	-	-	-	89.0	7.0	8,209	-	-	-
87-7	Down	138.0	B	8,346	8,590	-	-	-	-	-	62.0	6.7	8,277	-	-	-
Humble	Down	-	Surface	10,035	10,035	-	-	-	13.0	8,442	68.0	6.0	8,368	28.0	5.0	8,335
F76-1	Down	1,915	Surface	9,449	9,449	3.7	8,003	206.6	1.5	7,795	-	-	-	-	2.5	7,668
F76-2A	Down	1,814	Surface	9,559	9,559	5.4	8,072	167.0	2.1	7,903	-	-	-	-	11.4	7,758
F77-3B	Down	1,778	Surface	9,435	9,435	4.4	8,022	216.0	3.0	7,803	-	-	-	-	6.8	7,697

Table 2

U.S. Fuel Company Drill Holes Summary

Drill Hole No.	Direction of Drilling	Total Depth of Hole	Where Collared	Collar Elev.	Surface Elev.	Upper Seam		Interval Between Upper and B Seams	B Seam		Interval Between B and A Seam	A Seam		Interval Between A and Hiawatha Seams	Hiawatha Seam	
						Height	Elev.		Height	Elev.		Height	Elev.		Height	Elev.
F76-4	Down	1,680	Surface	9,337	9,337	3.9	8,003	207	2.0	7,794	-	-	-	-	17.5	7,679
F77-5	Down	1,735	Surface	9,344	9,344	7.0	7,950	217	2.0	7,731	-	-	-	-	14.2	7,622
F76-6	Down	1,700	Surface	9,250	9,250	8.2	7,949	196	1.4	7,752	-	-	-	-	6.0	7,615
F76-7A	Down	1,652	Surface	9,279	9,279	8.5	7,966	192	2.1	7,772	-	-	-	-	9.5	7,659
F76-8A	Down	1,645	Surface	9,249	9,249	2.2	7,984	175	4.3	7,805	-	-	-	-	6.4	7,660
F76-9	Down	1,580	Surface	9,209	9,209	5.4	8,016	187	2.9	7,826	-	-	-	-	2.9	7,667
76-10	Down	-	Surface	9,851	9,851	4.2	8,681	273	8.8	8,399	23.8	4.2	8,371	79.0	3.7	8,288
F77-11A	Down	1,925	Surface	9,352	9,352	7.0	7,938	203	2.0	7,733	-	-	-	-	0.2	7,597

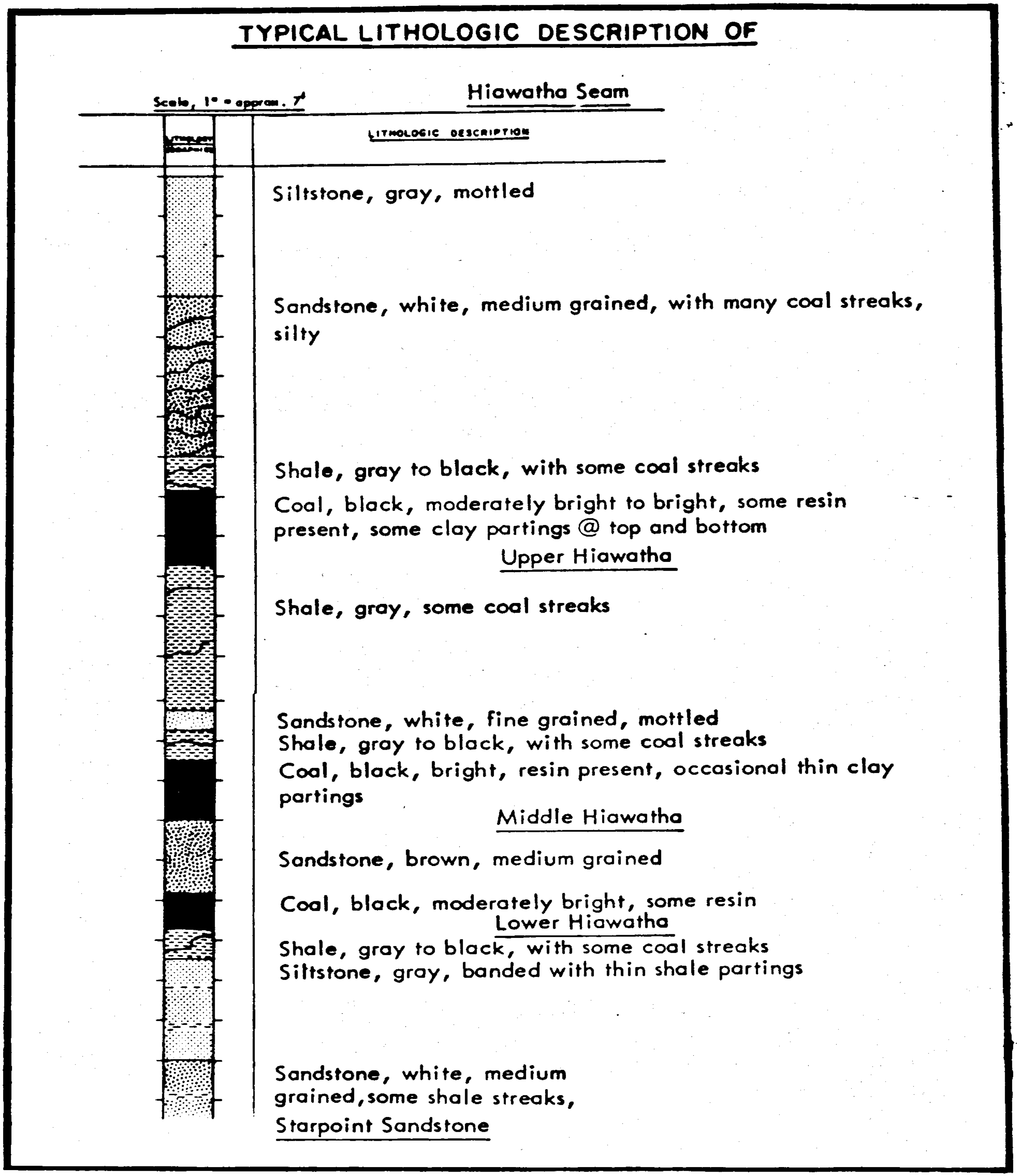

Figure 2 Typical Lithologic Description of Hiawatha Seam Interval.

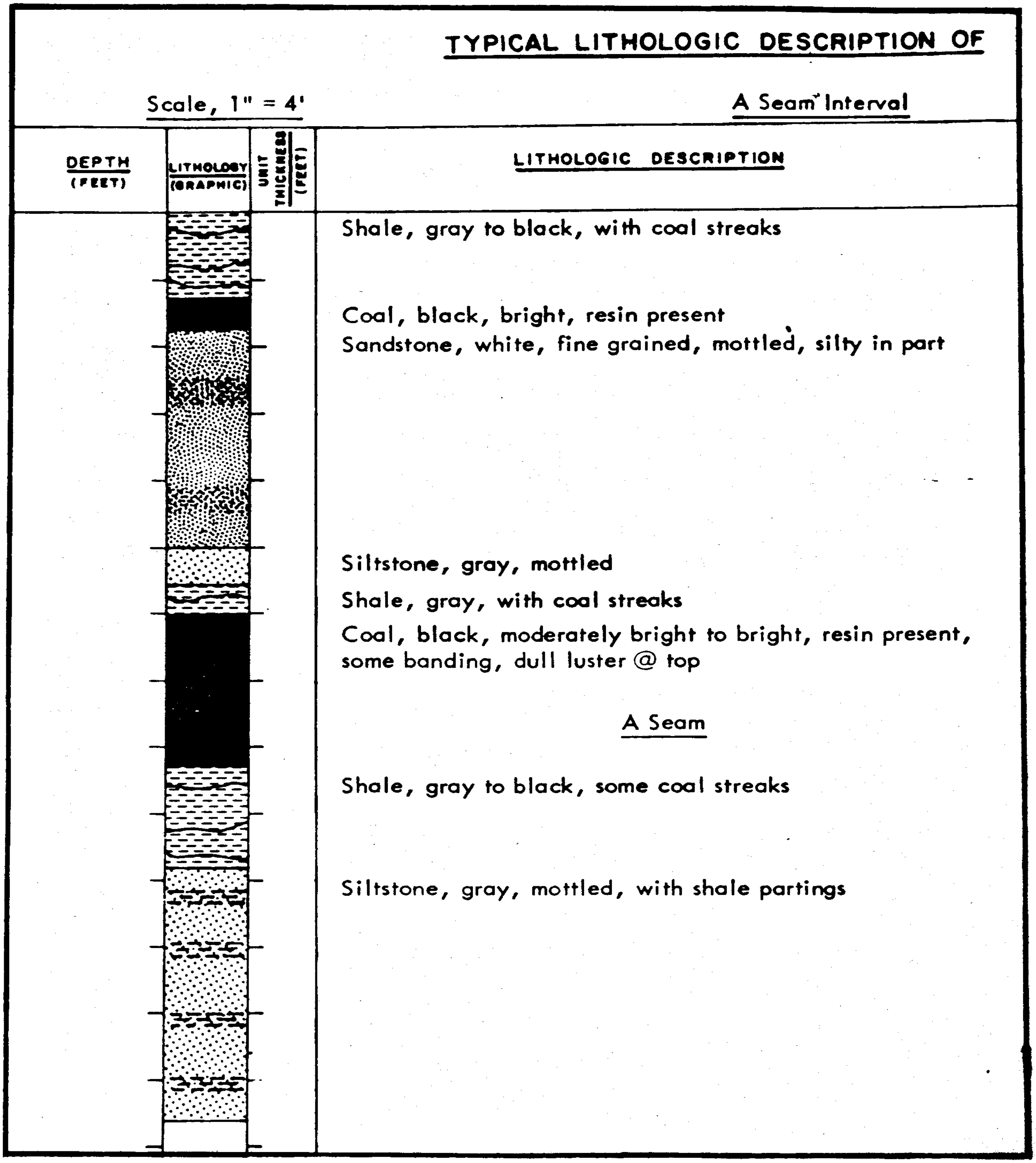

Figure 3 Typical Lithologica Description of the A Seam Interval.

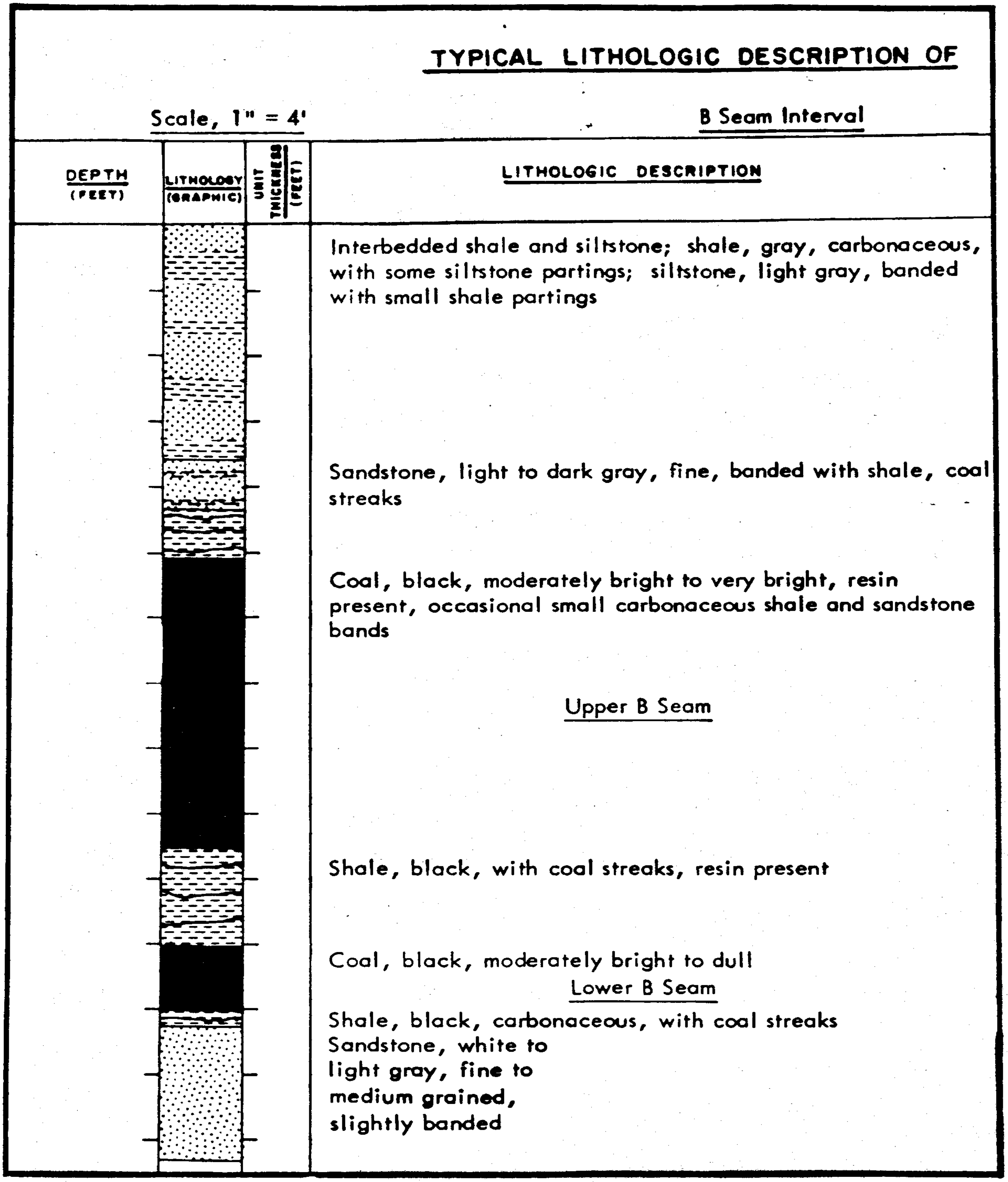

Figure 4 Typical Lithologic Description of The B Seam Interval.

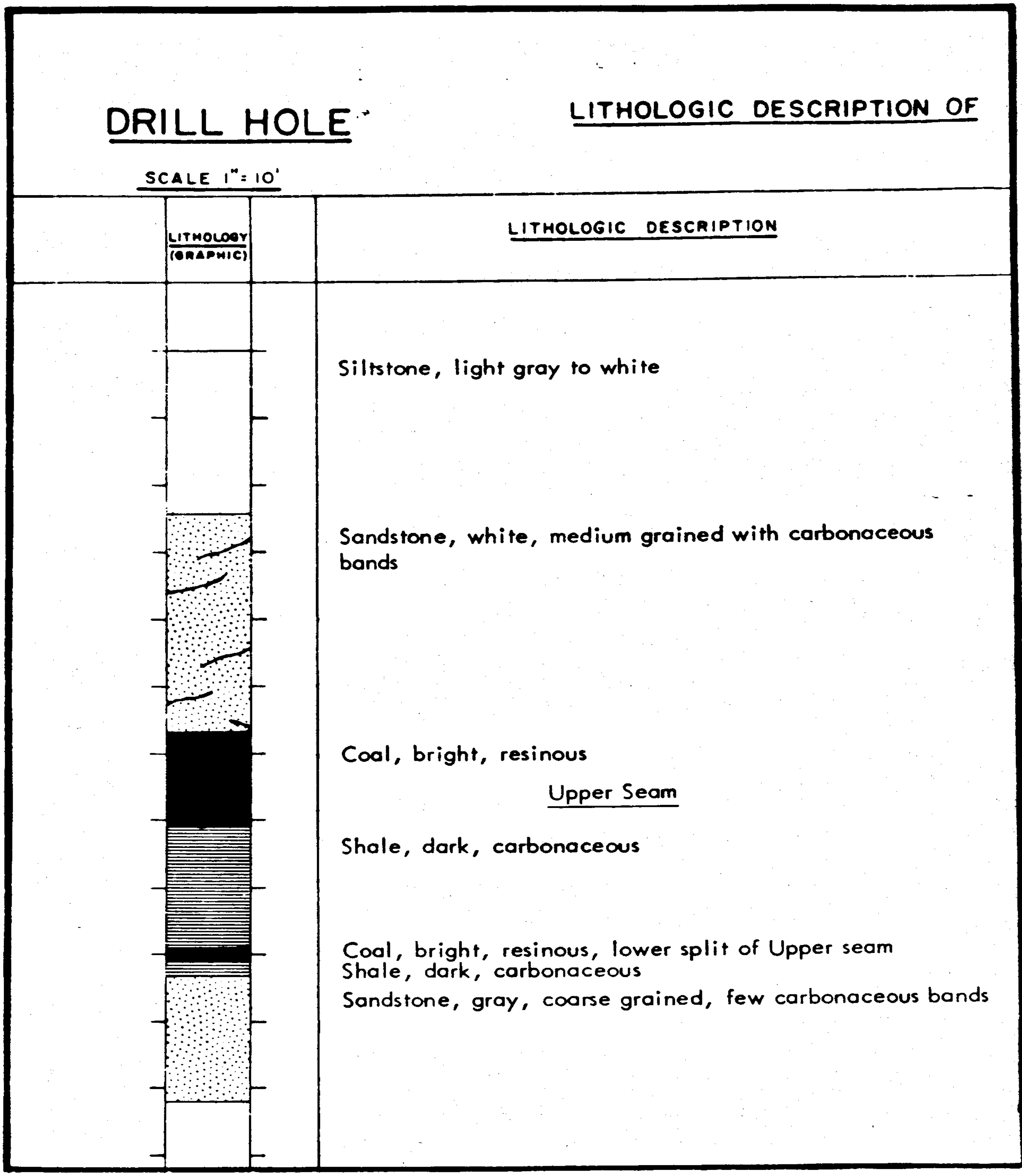

Figure 5 Typical Lithologic Description of The Upper Interval.

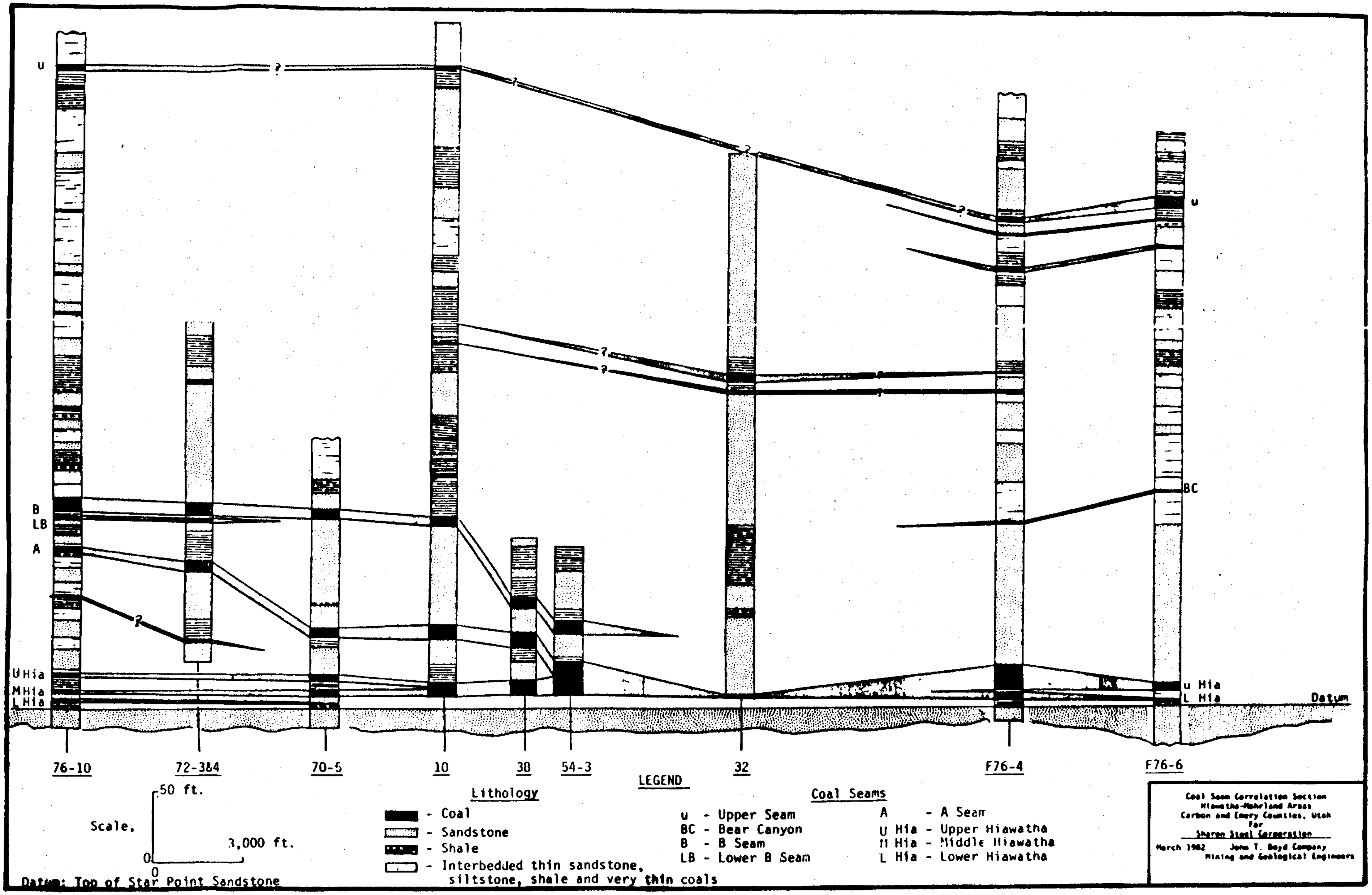

Figure 6 North-South Cross-Section Through Permit Area. See Exhibit 6-3 for Drill Hole Locations.

Geologic Effects On Surface and Ground Water

Geology is the principal factor controlling the occurrence and availability of groundwater. Unconsolidated deposits of Quaternary age are the most permeable water-bearing formations in parts of this region; sandstone strata of Jurassic, Cretaceous and Tertiary age contain the most extensive bedrock aquifers (Price, and Arnow, 1974).

The upper formations in this area are modified by deeply cut drainage systems which drain the exposed bedrock. The upper water-bearing beds are discontinuous and partially void of water near cliff faces (Final EIS, 1979). Field investigations have shown that most of the springs and seeps outcrop in the Price River, Star Point, and Castlegate Sandstone formations. The flagstaff limestone and North Horn formations are conglomerates composed of limestone yielding water to wells for municipal use at Price, Utah. High elevation aquifers can best be described as perched aquifers, these are generally the springs that recharge the perennial streams.

Directions and rates of ground water movement are controlled mainly by geologic structures and varieties in rock permeability. ~~Due to faulting and the dip of rock strata some ground water migrates between drainage within that basin.~~

~~Water entering the rocks at higher elevations may potentially find its way to the coal seams.~~ Ground water is encountered from time to time in the course of mining. Usually it occurs in the form of drippers or small steady trickles from the roof and floor.

These generally tend to decrease and dry up as development advances. Large water flows have been encountered in the past, mainly due to contact with faults. Water flows have been noted where mine workings have contacted the Bear Canyon fault. A fault zone of small displacement in the northern part of the King 4 mine, although not producing a measurable flow, is considered wet due to intermittent dripping along it. Since the dip of the beds in this area is toward the southwest, all water encountered in mining tends to flow to the most southerly opening, the old Mohrland portal. This flow supplies the town of Hiawatha ~~and U.S. Fuel's coal preparation plant~~. Jointing, where it can be observed, is approximately east-west and in some places inclined from 60 to 70 degrees to the south. This feature or its orientation has not been found to have any particular significance to water inflations of mine workings.

Since all mines are currently sealed it is impossible to monitor any in mine sources. The cumulative result of the sources in monitored as it comes out of the old Mohrland mine portal

~~Since Mined out areas of the mines are sealed off and abandoned shortly following retreat mining it is difficult to monitor individual sources of in-mine flows for any significant period of time. It is possible, however, to monitor the cumulative results of these flows where they pass through accessible workings. One such location exists in the southern part of the King 4 mine (identified as proposed monitoring site UG-1 on Exhibit 6-3). Due to the dip of the beds , monitoring the flow at this location will reflect the cumulative result of all sources originating in the King 4 mine north of the 10 West East sections.~~

A more detailed description of geologic effects on surface and ground water is given in Chapter 7, Hydrology.

Geologic Effects of Mining

Existing surface facilities are all located on ~~U.S. Fuel~~ Hiawatha Coal Company land. The Middle Fork of Miller Creek has King No. 6 facilities. These facilities are located in canyons near coal outcrops. Disturbed areas are comprised essentially of quaternary alluvium material ranges in thickness from thin sheets to over 50 feet. It has very good physical properties and provides a good foundation for surface structure.

All existing mine portals are located within 300 feet vertically from the top of the Star Point Sandstone formation. Excavations in bedrock for portal face-up areas affect sandstones, shales and siltstones of the lower part of the Blackhawk Formation. Some minor ground water seeps may occur in these areas. No overburden has been removed for the purpose of mining coal. The coal preparation plant along with related yards, refuse disposal sites, and slurry ponds are located on thick gently sloping alluvial deposits.

Fresh core samples of roof and floor strata adjacent to coal seams have been collected and analyzed to identify clay content, acid forming, and alkalinity producing materials. The result of these analyses are given in Table 3. Coal refuse, comprised of roof, floor and in-seam waste rock segregated from mine-run coal, is deposited in refuse piles and slurry pond embankment near the preparation plant. A discussion of this material including its suitability for reclamation and potential toxicity to plants and animals is given in Chapter 2 under Coal Refuse Materials (R645-301-230 Operation Plan). Tables 4 through 8 summarize analytical data relating to toxic-forming material present in the refuse. Table 1 gives chemical analysis the coal seams summarized from numerous samples collected over many years. Note that this table includes analyses of pyretic, sulfate and organic sulfur.

In response to the Division's Technical Deficiency Review of March 4, 1992 a composite sample of coal refuse was collected by U. S. Fuel Company from slurry ponds 1, 4 and 5 and analyzed for both acid/base potential and toxic-forming material in accordance with Table 6 of the Division's "Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining". The result of this analysis is presented in Table 9.

~~U.S. Fuel's~~ Hiawatha's underground mining system has been designed for full extraction of multiple seams where technically and economically feasible. The current minimum economic mining thickness is 5 feet. The areas of proposed coal extraction for all seams are shown on Exhibit 5-2D.

Table 3

Analysis of Coal Seam Roof and Floor Samples

Sample I.D.	PS #	NP T/1000T	AP T/1000T	ABP T/1000T	CLAY #
76-6 Upper Seam-Roof	<.01	82.3	<.1	82.3	-
76-6 Upper Seam- Floor	.03	6.4	.9	5.5	<1
76-6 Hiawatha- Roof	<.01	276.9	<.1	276.9	-
76-6 Hiawatha-Floor	.06	5.5	1.9	3.6	<1
76-10 A Seam-Roof	.04	37.3	1.3	36.0	-
76-10 A Seam-Floor	.06	5.1	1.9	3.2	<1
76-10 B Seam-Roof	.12	6.0	3.8	2.2	-
76-10 B Seam-Floor	.17	6.4	5.3	1.1	<1
76-8a Hiawatha-Roof	.04	68.5	.1	68.4	-
76-8a Hiawatha-Floor	.21	0.0	6.6	-6.6	<1
76-7a Upper Seam-Roof	.02	42.3	.6	41.7	-
76-7a Upper Seam-Floor	.09	52.9	2.8	50.1	<1
77-3b Hiawatha-Roof	<.01	83.7	<.1	83.7	-
77-3b Hiawatha-Floor	.09	5.1	2.8	2.2	<1
77-3b Upper Seam-Roof	.16	70.8	5.0	65.8	-
77-3b Upper Seam-Floor	.26	13.8	8.1	5.7	<1
76-2a Upper Seam-Roof	.15	38.2	4.7	33.5	-
76-2a Upper Seam-Floor	.02	4.1	.6	3.5	<1
76-2a Hiawatha-Roof	.02	295.3	.6	294.7	-
76-2a Hiawatha-Floor	.18	29.0	5.6	23.4	<1
79-1 A Seam-Roof	<.01	84.6	<.1	84.6	-
79-1 A Seam-Floor	.04	29.4	1.3	28.1	<1
79-1 B Seam-Roof	.04	77.3	1.3	76.0	-
79-1 B Seam-Floor	<.01	85.1	<.1	85.1	<1

PS – Pyrite Sulfur, % EPA 3.2.4.
NP – Neutralization Potential Tons/1000 Ton CaCO3 Equivalent, EPA 3.2.3.
AP – Acidity potential Tons/1000 Ton $CaCO_3$ Equivalent, EPA 3.2.4.
ABP – Acid/Base Potential (Acid/Base Acct.)[3] -= Excess Acid; +=Excess Base
Ton/1000 aTons $CaCO_3$ Equivalent (Smith Sec. 7).
CLAY - %, EPA 3.4.3.

The areas ~~currently being mined are~~ of proposed mining will be developed in panels to their extremities. When a panel is fully developed, it is then retreat-mined, using full extraction methods. The method of full extraction used currently is pillar robbing. Coal is extracted in a zone of pressure arching over the working face from a rear abutment zone (caved and compressed rock) to a front abutment zone. The front abutment zone is a developed room-and-pillar panel. Any coal left behind while pillar-robbing is crushed out as the rear abutment zone follows the direction of retreat.

Tests for engineering properties have been conducted on coal and rock cores in the current mining area. The results, given in Appendix 6-1, have been used when predicting pillar dimensions in current mining operations. The extent of geotechnical testing is limited. Because a great deal of hands-on mining experience has been gained through the years, the need for geotechnical studies is greatly reduced. Coal pillar design is a dynamic process that evolves during the course of mining as experience is gained with local ground conditions.

Main entries and crosscuts are laid out on 80 to 100 foot centers with 20-foot entry width, leaving pillars 80 X 80 feet down to 60 X 60 feet. In panels, rooms and crosscuts are laid out on 55X 110 foot centers with 20 foot entry widths.

No full extraction is projected in areas containing full extraction in underlying seams with an interburden less than 40 feet. In areas where conventional or partial extraction underlay projected mining with less then 40 feet of interburden exist, conditions will be evaluated during development to determine if any extraction can take place. Subsidence has been evaluated assuming the worst-case scenario will full extraction taking place.

Some multiple seam situations, such as in the King 6 mine, occur where the adjacent seam is mined out, but not fully extracted, and the rock interval between the seams is less than 40 feet. Under these difficult conditions underlying development headings must be aligned precisely with older workings above so as to avoid mining beneath concentrated loads. ~~Multiple seam mining is currently projected for recovery of A seam reserves in the King 4 mine as well. Rock tunnels form the B seam within the mine are expected to be driven to the A seam at some future date~~.

Mine development headings are supported on a full roof support system with special roof bolting provisions specified by MSHA approved roof control plans. Roof span during pillar recovery is a function of pillaring methods and is not limited to 20 feet in the relaxed arch-core near the breakline. Mine opening support and protection methods to be used are in accordance with MSHA regulations.

Any subsidence occurring as a result of full extraction mining methods will be controlled and uniform. Mining practices that can result in subsidence will be conducted far enough away from coal outcrops so that the outcrops are not projected in the vicinity of perennial stream buffer zones.

Table 4

Slurry Pond Embankments
Concentrations of Biologically Active Trace Metals

Area	Al (ppm)	B (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Pb (ppm)	Mn (ppm)	Hg (ppm)	Se (ppm)	Zn (ppm)	PH
Slurry Pond No. 5	2.78 (L)	1.08 (L)	0.03(L)	0.05(L)	0.20(L)	0.63(L)	0.94(L)	2.06(L)	<1.0(L)	1.30(M)	<0.01(L)	7.86(G)
Slurry Pond No. 3	2.26 (L)	4.70 (L)	0.04(L)	0.06(L)	0.22(L)	0.31(L)	10.7(L)	0.65(L)	2.0(L)	1.50(M)	<0.01(L)	7.85(G)
Slurry Pond No. 1	1.6 (L)	3.40 (L)	0.02(L)	0.03(L)	0.18(L)	1.10(L)	0.73(L)	0.29(L)	<1.0(L)	0.91(M)	<0.01(L)	8.52(F)
Slurry Pond No. 4	2.92 (L)	0.20 (L)	0.05(L)	0.08(L)	0.28(L)	15.8(H)	1.44(L)	5.50(L)	20.0(L)	1.93(M)	<0.01(L)	7.35(G)
Slurry Pond No. 4			0.01 (L)	0.01(L)			0.002(L)		1.5(L)	0.003(L)		7.5(G)

Concentrations of trace metals:

L = Low concentrations, no toxicity to plants or animals
M = Moderate toxicity, very slight toxicity to plants, moderate to animals
H = High concentrations, potentially toxic to plants and animals or acid- forming material treatment needed

PH:

G = Good PH, no treatment required
F = Fair PH, limited treatment needed

Table 5

Coal Refuse Laboratory Analyses

Area	OM	SP [a]	PH	ECe [b]	CEC [c]	SAR	Na [d]	Ca [d]	Mg [d]	HCO3 [d]	NO3-N [e]	N	P [e]	K [e]	>2mm	Sand [f]	Silt [f]	Clay [f]	Texture
Slurry Pond No. 1	85.8	43	7.8	1.7	2.2	0.2	0.6	14.6	7.8	0.9	<0.1	0.95	<0.5	34	0	90	6	4	Sand
Slurry Pond No. 3	80.6	69	7.8	3.4	6.6	0.1	0.7	22.5	24.2	1.6	3.8	1.1	<0.5	41	0	65	29	6	Sandy loam
Slurry Pond No. 4	25.8	33	6.8	4.3	6.8	0.1	0.7	21.1	43.0	3.2	<0.1	0.24	3.6	75	0	75	15	10	Sandy loam
Slurry Pond No. 5	37.1	34	7.3	3.1	10.2	0.2	0.9	23.8	17.8	1.8	1.1	0.43	4.6	64	0	68	18	14	Sandy loam

a = SP = Percent water at saturation

b = ECa = Electrical Conductivity of saturation extract in mmhos/cm

c = ECE = Cation exchange capacity in meq/liter

d = M2O = Solution in saturation extract meq/liter

e = In parts per million

f = In percent

Table 6

Coal Refuse Characteristics Which Affect Suitability For Plant Root Growth

Area	OM %	S	SP %	S	PH	S	Texture	S	ECe	S	CEC	S	SAR	S	AWC In./ft.	S	HCO3 Meq/l	S	NO3-N ppm	S(1)	N %	S(1)	P ppm	S(1)	K ppm	S (1)
Slurry Pond No. 1	85.8	G	43	F	7.8	G	S	P	1.7	G	2.2	G	0.2	G	0.7	F	0.9	G	<0.1	L	0.95	L	0.5	L	34	L
Slurry Pond No. 3	80.6	G	69	F	7.8	G	SL	G	3.4	G	6.6	G	0.1	G	1.3	F	1.6	G	3.8	L	1.1	L	0.5	L	41	L
Slurry Pond No. 4	25.8	G	33	F	6.8	G	SL	G	4.3	F	6.8	G	0.1	G	1.2	F	3.2	G	<0.1	L	0.24	L	3.6	L	75	G
Slurry Pond No. 5	37.1	G	34	F	7.3	G	SL	G	3.1	G	10.2	G	0.2	G	1.3	F	1.8	G	1.1	L	0.43	L	4.6	L	64	G

OM = Organic matter percent
S = Suitability rating (good, fair, poor, unsuitable)
SP = Saturation Percentage
Texture = USDA soil texture (S = sand, SL = sandy loam)
ECa = Electrical Conductivity of saturation extract
CEC = Cation exchange capacity meq/liter
SAR = Sodium absorption ratio meq/liter
AWC = Available water capacity inchs/foot
S (1) = Suitability of available nutrients (G = good, no amendments needed; L = low, amendments needed)

Table 7

Slurry Pond No. 1 Biologically Active Trace Metals Concentrations and Suitability

Area	Al ppm	S	B ppm	S	Cd ppm	S	Cu Ppm	S	Fe ppm	S	Hg ppm	S	MN ppm	S	Pb ppm	S	Se ppm	S	Zn ppm	S	PH	S
Sample A	0.39	L	0.40	L	<0.01	L	2.0	L	70	L	<0.002	L	1.2	L	<0.01	L	<0.01	L	2.4	L	6.0	G
Sample B	0.46	L	0.38	L	<0.01	L	2.0	L	37	L	<0.002	L	1.3	L	<0.01	L	<0.01	L	4.2	L	7.4	G

Concentrations of Trace Metals:
L = Low concentrations, no toxicity of plants or animals
PH = G = Good PH, no treatment required

Table 8

Slurry Pond No. 1 Suitability of Refuse For Reclamation

Area	PH	(h) S	(a) EC	S	(b) SAR	S	(c) Sp	S	(d) AWC	S	(e) Texture	S	(f) CF	S	(g) MC	S	OM	S
Sample A	6.0	G	2.5	G	0.2	G	40	G	7.8	F	SL	G	54.1	P	LO	F	44.2	G
Sample B	7.4	G	3.5	G	3.5	G	37	G	6.4	F	SL	G	27.5	F	Lo	F	37.7	G

a = EC = Electric conductivity in mmhos/cm
b = SAR = Sodium adsorption ratio
c = SP = Percent water at saturation
d = AWC = Available water capacity in percent

e = Texture = SL = Sandy loam
f = CF = Percent coarse fragments greater than 2mm
g = MC = Moist consistency Lo = Loose
h = S = Suitability (G = good, F = fair, P = poor)

Table 9

Coal Refuse Composite Sample
Collected From Slurry Ponds 1, 4 & 5 On June 30, 1992

Parameters	Concentration	Units	Notes
Saturation %	40	%	
PH, saturated paste	5.7	units	1
Conductivity, saturated paste	3.24	mmhos/cm	1
Calcium, soluble	19.5	meq/l	1
Magnesium, soluble	41.0	meq/l	1
Sodium, soluble	0.61	meq/l	1
Sodium Absorption Ratio	0.1		
Cation Exchange Capacity	10	meq/100g	
Exchangeable Sodium %	0.8	%	
Nitrate as N, soluble	2.4	mg/kg	2
Nitrogen, total Kjeldahl	0.30	%	
Boron, soluble	1.2	mg/kg	3
Selenium, Soluble	0.06	mg/kg	3
Sulfur, organic	0.41	%	
Sulfur, pyretic	0.05	%	
Sulfur, sulfate	0.44	%	
Sulfur, total	0.90	%	
Neutralization Potential	0.7	% as Ca CO3	
Acid-Base Potential (Ca CO3)	5	Tons/1000	4
Organic Carbon	5.2	%	
Available Water Capacity	0.09	in/in	
Coarse Fragments > 2 mm	55.9	%	
Sand 2.00 – 0.062 mm	66.0	%	
Silt 0.062 – 0.002 mm	19	%	
Clay < 0.002 mm	15	%	
Texture	Sandy Loam		

NOTES:
1. Saturated Paste Extraction
2. Water Extraction
3. Hot Water Extraction
4. Calculated from pyretic sulfur.

The process of subsidence control employed consists of laying out panels for full extraction of sufficient width to avoid delayed caving and to result in a broad neutral zone overlying the mined out panel in which no tension or pressure exists at the surface subsidence. For full extraction mining in wide panels, the maximum subsidence at the surface is a function of thickness of coal seam extracted and depth of cover. The thicker the extracted coal, the greater the subsidence. Conversely, the deeper the cover, the less the subsidence due to swell of gob. In areas where multiple seam mining is practiced, the maximum combined thickness of fully extracted coal may amount to as much as 25 feet. Cover depths over full extraction areas may range from 300 to 2,000 feet, with maximum subsidence ranging from 20 feet down to 3 feet, respectively, in areas where total thickness extracted is 25 feet. These estimates represent extreme condition which are rarely encountered. More typical subsidence for the permit area would range from 7 feet down to 1.2 feet for the 300 to 2,000 foot cover depths, respectively. These predications are based on data collected by the National Coal Board (UK) for their "Subsidence Engineer's Handbook" (1975).

No significant surface structure such as building, power lines, pipelines or oil-and-gas wells exist within projected mining areas. A few dirt roads, fence lines and stock watering ponds do exist and could be influenced. A subsidence monitoring plan has been developed and is discussed in Chapter 5, Engineering.

REFERENCES:

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Spieker, E.M., 1930, The Wasatch Plateau Coal Field, Utah: U.S.G.S Bulletin 819.

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R645-301-621 General Requirements

A description of the geology within the proposed permit and adjacent areas that may be affected or impacted by the proposed cal mining and reclamation operation is given under R645-301-621 and R645-301-724 through 731.

R645-301-622 Cross-Sections, Maps and Plans

622.100 Elevations of test boring and core sampling are given in Table 2 and on Exhibit 6-3.

622.200 The nature, depth and thickness of the coal seams to be mined, any coal or rider seams above the seam to be mined, each stratum of the overburden and the stratum immediately below the lowest coal seam to be mined are shown in Table 2, in Figures 2 through 6, on Exhibits 6-2, and 6-4 thru 6-12. Figures 13a and 13b on pages 62 and 63 of Appendix 7-21 show typical thickness of all geologic formations and offsets due to faults.

622.300 Coal crop lines and the strike and dip of the coal to be mined are shown on Exhibits 5-1, 5-2, 6-1, ~~and~~ 6-3, 6-6, 6-9, and 6-12.

622.400 There are no gas or oil wells within the permit area.

R645-301-623 Geologic Information

623.100 Geologic information to assist in determining potentially acid or toxic-forming strata is discussed under R645-301-620 (Geologic Effects of Mining) and summarized in Table 1 and Tables 3 through 9 in this Chapter.

623.200 Geologic information to assist in determining whether reclamation can be accomplished is given under R645-301-231 (Coal Refuse Materials), R645-301-620 (Geologic Effects of Mining) and R645-301-724.600 (Areas of Potential Subsidence).

623.300 Geologic information to assist in preparing the subsidence control plan is given under R645-301-332 (Anticipated Impacts of subsidence), R645-301-525 (Subsidence Control Plan) and R 645-301-724.600 (Survey of Renewable Resource Lands).

R645-301-624 Additional Geologic Information

624.100 This information is given under R645-301-620, R645-301-724 and R645-301-724.600.

624.110 See R645-301-623.

624.120 See R645-301-624.200, R645-301-624.300 and R645-301-625.

624.130 Geologic literature and practice are referenced under R645-301-610.

624.200 Does not apply. See 624.300.

624.210 Does not apply. See 624.300.

624.220 Does not apply. See 624.300.

624.230 Does not apply. See 624.300.

624.300 Samples have been collected and analyzed from drill cores and refuse samples to meet the requirements of this rule. See Table 1 and Tables 3 through 9.

624.310 Lithologic characteristics, including physical properties and thickness of stratum that may be impacted are shown in Figures 2 through 6. The location of ground water where occurring is discussed under R645-301-600 (Potential Water Bearing Zones).

624.320 Chemical analyses for acid or toxic-forming or alkalinity-producing material and their content is the strata immediately above and below the coal seams to be mines are given in Tables 3 through 9.

624.330 Chemical analyses of the coal seams are given in Table 1.

624.340 No significant amount of clay was detected in the samples analyzed. See Table 3.

R645-301-630 Operation Plan

R645-301-631 Casing and Sealing of Exploration Holes and Boreholes

In the past, exploration bore holes have been sealed according to a plan recommended by the U.S.G.S., whereby multiple coal beds are cemented from the bottom of the hole to a point 50 feet above the highest coal bed that is 4 feet or greater in thickness. The hole collar is plugged with 5 feet of concrete. This same method will be used for future boreholes unless they are approved for water monitoring.

Should the need arise to install groundwater wells ~~U.S. Fuel~~ Hiawatha commits to follow Utah Code Section 73-3-25 and Utah Rules for Water Well Drillers for groundwater monitoring well installation and abandonment.

R645-301-632 Subsidence Monitoring

A subsidence Monitoring Plan along with a map showing the location of monitoring points (Exhibit 5-3) is given in Chapter 5 under R645-301-525. A determination of the commencement and degree of subsidence is discussed under the above heading as well as in Chapter 7 under R645-301-724.